

**WHAT IS CLAIMED IS:**

1. A temperature/humidity control system for a fuel cell stack, comprising:  
a humidifying device having a vibrator configured to convert water into vapor,  
a storage member storing the vapor generated by the vibrator, and at least one mixing  
5 member configured to humidify hydrogen and air that are supplied to the fuel cell stack  
with the vapor stored in the storage member;

a preheating device configured to preheat the hydrogen and air humidified by  
the at least one mixing member;

at least one temperature sensor detecting temperatures of the hydrogen and the  
10 air having passed the preheating device and a temperature of coolant of the fuel cell  
stack, and outputting corresponding signals;

at least one humidity sensor detecting humidities of the hydrogen and the air  
having passed the humidifying device and outputting corresponding signals; and

a fuel cell control unit controlling the humidifying device and the preheating  
15 device based on signals from the at least one temperature sensor and the at least one  
humidity sensor.

2. The control system of claim 1, wherein the mixing member comprises:  
a first mixing member disposed in a hydrogen supply line; and  
a second mixing member disposed in an air supply line.

20 3. The control system of claim 2, wherein each of the first mixing  
member and the second mixing member includes a venturi tube that is configured to  
draw the vapor from the storage member.

4. The control system of claim 1, wherein the preheating device  
comprises:

25 a first preheating member that is disposed in a hydrogen supply line; and  
a second preheating member that is disposed in an air supply line.

5. The control system of claim 4, wherein each of the first and second  
preheating members includes a variable resistor that is able to emit heat by a current  
flow therethrough.

6. The control system of claim 1, wherein the preheating device comprises at least one preheating member configured to emit heat using supplied current, and a preheating switch being able to selectively electrically connect the preheating member and an electric power source together in response to a control signal of the fuel cell control unit, and wherein the humidifying device further comprises a vibrator operating switch that is configured to selectively electrically connect the vibrator and the electric power source together.

7. The control system of claim 1, further comprising an accumulator that is configured to store water generated by a reaction between hydrogen and water in the fuel cell stack.

8. The control system of claim 7, further comprising a drain portion that is installed to the accumulator, the drain portion being configured to exhaust water stored therein when an amount of stored water is greater than a specific level.

9. The control system of claim 1, wherein the at least one temperature sensor comprises:

a first temperature sensor detecting a temperature of hydrogen having passed the preheating device; and

a second temperature sensor detecting a temperature of air having passed the preheating device.

10. The control system of claim 9, wherein the fuel cell control unit controls the preheating device to preheat hydrogen supplied to the fuel cell stack if a hydrogen temperature detected by the first temperature sensor is lower than a first predetermined temperature, and wherein the fuel cell control unit controls the preheating device to preheat air supplied to the fuel cell stack if an air temperature detected by the second temperature sensor is lower than the first predetermined temperature.

11. The control system of claim 9, wherein the fuel cell control unit controls the preheating device to not preheat hydrogen supplied to the fuel cell stack if a hydrogen temperature detected by the first temperature sensor is higher than a second

predetermined temperature, and wherein the fuel cell control unit controls the preheating device to not preheat air supplied to the fuel cell stack if an air temperature detected by the second temperature sensor is higher than the second predetermined temperature.

5           12.     The control system of claim 7, wherein the preheating device is connected to the fuel cell stack through a first passage and the accumulator is connected to the preheating device through a second passage such that coolant in the fuel cell stack can be transferred to the accumulator via the preheating device, a first valve is disposed within the first passage to control a flow of coolant from the fuel cell stack to the preheating device, a second valve is disposed within the second passage to control a flow of coolant from the preheating device to the accumulator, and operations of the first and second valves are controlled by the fuel cell control unit.

10           13.     The control system of claim 12, wherein the preheating device includes a variable resistor, a resistance of which is controlled by the fuel cell control unit and that is configured to emit heat according to a current flow, and wherein the at least one temperature sensor includes a third temperature sensor detecting a temperature of the coolant in the fuel cell stack, and wherein the fuel cell control unit controls the first and second valves to be open and the variable resistor to lower the resistance thereof if a coolant temperature detected by the third temperature sensor is higher than a third predetermined temperature.

15           14.     The control system of claim 13, wherein the control unit controls the first and second valves to be open and the preheating device to not operate if the coolant temperature detected by the third temperature sensor is higher than a fourth predetermined temperature.

20           15.     The control system of claim 14, wherein the fourth predetermined temperature is determined as a temperature at which hydrogen and air supplied to the fuel cell stack can be preheated to a specific temperature only by the coolant that is transferred to the accumulator from the fuel cell stack via the preheating device.

          16.     The control system of claim 1, wherein the at least one humidity sensor

comprises:

a first humidity sensor detecting a humidity of hydrogen having passed the humidifying device and outputting a corresponding signal; and

a second humidity sensor detecting a humidity of air having passed the humidifying device and outputting a corresponding signal.

17. The control system of claim 16, wherein the fuel cell control unit controls the vibrator such that an amount of vapor generated by the vibrator is increased if at least one of a hydrogen humidity detected by the first humidity sensor and an air humidity detected by the second humidity sensor is lower than a first predetermined humidity.

18. The control system of claim 16, wherein the fuel cell control unit controls the vibrator such that an amount of vapor generated by the vibrator is decreased if both of the hydrogen humidity detected by the first humidity sensor and the air humidity detected by the second humidity sensor are higher than a second predetermined humidity.

19. The control system of claim 1, wherein the at least one temperature sensor comprises a third temperature sensor detecting a temperature of coolant in the fuel cell stack, and wherein the fuel cell control unit controls hydrogen and air supplied to the fuel cell stack to be preheated by at least one of the preheating device and the coolant in the fuel cell stack, based on the detected coolant temperature.

20. The control system of claim 19, wherein the hydrogen and the air supplied to the fuel cell stack are preheated only by the preheating device if the coolant temperature is lower than a third predetermined temperature.

21. The control system of claim 19, wherein the hydrogen and the air supplied to the fuel cell stack are preheated by the preheating device and the coolant in the fuel cell stack if the coolant temperature is between the third predetermined temperature and a fourth predetermined temperature.

22. The control system of claim 19, wherein the hydrogen and the air

supplied to the fuel cell stack are preheated only by the coolant if the coolant temperature is higher than a fourth predetermined temperature.

23. A temperature/humidity control method for a fuel cell stack using a humidifying device capable of humidifying hydrogen and air supplied to the fuel cell stack and a preheating device capable of preheating the hydrogen and air supplied to the fuel cell stack, comprising:

detecting temperatures of hydrogen and air having passed a preheating device;  
detecting humidities of the hydrogen and the air having passed a humidifying device; and

controlling the humidifying device and the preheating device based on temperatures and humidities of the hydrogen and the air.

24. A temperature control method for a fuel cell stack using a preheating device capable of preheating hydrogen and air supplied to the fuel cell stack, comprising:

detecting a temperature of hydrogen having passed a preheating device;  
detecting a temperature of air having passed a preheating device; and  
controlling the preheating device based on the detected hydrogen temperature and the detected air temperature.

25. The control method of claim 24, wherein the controlling the preheating device controls the preheating device to preheat the hydrogen supplied to the fuel cell stack if the detected hydrogen temperature is lower than a first predetermined temperature, and wherein the controlling the preheating device controls the preheating device to preheat the air supplied to the fuel cell stack if the detected air temperature is lower than the first predetermined temperature.

26. The control method of claim 24, wherein the controlling the preheating device controls the preheating device to not preheat the hydrogen supplied to the fuel cell stack if the detected hydrogen temperature is higher than a second predetermined temperature, and wherein the controlling the preheating device controls the preheating device to not preheat the air supplied to the fuel cell stack if the detected air temperature

is higher than the second predetermined temperature.

27. The control method of claim 24, further comprising:

detecting a temperature of coolant in the fuel cell stack; and

allowing the coolant to circulate through the preheating device to preheat the  
5 hydrogen and the air supplied to the fuel cell stack and simultaneously decreasing the  
amount of heat generated by the preheating device, if the detected coolant temperature  
is higher than a third predetermined temperature.

28. The control method of claim 27, further comprising allowing the

coolant to circulate through the preheating device to preheat the hydrogen and the air  
10 supplied to the fuel cell stack and stopping an operation of the preheating device, if the  
detected temperature is higher than a fourth predetermined temperature.

29. The control method of claim 28, wherein the fourth predetermined

temperature is determined as a temperature at which the hydrogen and the air supplied  
to the fuel cell stack can be preheated only by the coolant to a specific temperature.

30. The control method of claim 24, further comprising detecting a

15 temperature of coolant inside the fuel cell stack, and

wherein the controlling the preheating device controls hydrogen and air  
supplied to the fuel cell stack to be preheated by at least one of the preheating device  
and the coolant in the fuel cell stack, based on the detected coolant temperature.

31. The control method of claim 30, wherein the hydrogen and the air

20 supplied to the fuel cell stack are preheated only by the preheating device if the coolant  
temperature is lower than a third predetermined temperature.

32. The control method of claim 30, wherein the hydrogen and the air

25 supplied to the fuel cell stack are preheated by the preheating device and the coolant in  
the fuel cell stack if the coolant temperature is between the third predetermined  
temperature and a fourth predetermined temperature.

33. The control method of claim 30, wherein the hydrogen and the air

supplied to the fuel cell stack are preheated only by the coolant if the coolant

temperature is higher than a fourth predetermined temperature.

34. A humidity control method for a fuel cell stack using a humidifying device having a vibrator converting water into vapor and capable of humidifying hydrogen and air supplied to the fuel cell stack, comprising:

- 5        detecting a humidity of hydrogen having passed a humidifying device;
- detecting a humidity of air having passed a humidifying device; and
- controlling the humidifying device based on the detected hydrogen humidity and the detected air humidity.

10        35. The control method of claim 34, wherein the controlling the humidifying device controls the vibrator such that an amount of vapor generated by the vibrator is increased if at least one of a hydrogen humidity detected by the first humidity sensor and an air humidity detected by the second humidity sensor is lower than a first predetermined humidity.

15        36. The control method of claim 34, wherein the controlling the humidifying device controls the vibrator such that an amount of vapor generated by the vibrator is decreased if both of a hydrogen humidity detected by the first humidity sensor and an air humidity detected by the second humidity sensor are higher than a second predetermined humidity.